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ABSTRACT

A variety of techniques are available for evaluating the success that implemented programs have in terms of achieving the expected and desired student outcomes and, by extension, the desired goals and objectives of the institution. Current approaches to such analysis are generally limited to the basic strategy of survey research. The two major strategies available to the survey researcher are cross-sectional and longitudinal analysis. Cross-sectional data obscure the input differences that might exist among various classes and differences that might result from selectivity factors at work in the advanced classes' history of dropouts. Longitudinal studies compensate for the first problem, but still do not account for the fact that students who drop out may differ from those who do not. The analysis of change scores may be faulty due to artificial dependence on initial scores. The use of input-output analysis makes it possible to ascertain the separate contributions of student input and program effects to the impact on student outcomes. Input-output analysis is a technique for statistically determining residual scores and then attributing the variation in residual scores to the environmental or program characteristics using step-wise linear regression techniques. Methods of applying this input-output technique to analyze the effect of intra-college programs on student development outcomes are discussed. (SC)

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# Analysis Techniques for Assessing the Effect of Higher Education on Student Development Outcomes

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## Analysis Techniques for Assessing the Effect of Higher Education on Student Development Outcomes

The administrative decision maker in higher education may have available many types of data about students: student characteristics; student achievements; student participation; student outcomes; etc. The way in which these data are gathered and analyzed will have a major impact on the interpretation and, therefore, the usefulness of them. Administratively, the purpose of collecting the data is to evaluate the success which implemented programs have in terms of achieving the expected and desired student outcomes, and by extension, the desired goals and objectives of the institution. This requires the decision maker to be able to make a statement about the degree to which the impact of the program has caused students to move toward the expected and desired student outcomes. This movement must be attributable to the program activities of the alternatives implemented, and differentiated from the impact of the student inputs, in order for the program to be realistically evaluated.

This question is not unlike that asked by many of the researchers concerned with the issue of college impact on students. "To show the impacts of college environment on students, something about the individual in impact terms (change, stability, outcome) must be connected with something about the environment ... Most studies relating test-retest differences of net change to environment ... have not adjusted for initial position of students on the variable under consideration." (3. p. 15). Marcus, et al (6) point out that current approaches to such questions are primarily

limited to the basic strategy of survey research. In this approach, the investigator " ... is forced, by the limitations of his methodology, to look for variables which could theoretically account for the observed relationships that are antecedent in temporal sequence to the independent and dependent variables. Thus, the researcher tests for spuriousness by statistically controlling for antecedent variables which could theoretically account for the original relationship" (6. p. 25). Most of the approaches to measuring student outcomes are of the survey type. Thus, it seems that the research methodology most appropriate for the decision maker in this situation would be that of survey research.

There are two major strategies available to the survey researcher -- cross-sectional and longitudinal. Data collected in each of these ways can be used appropriately by a decision maker if their methodological limitations are known and understood.

Cross-sectional data is that which is gathered at only one point in time. The data may be from several different classes of students, but all are submitting the data at the same point in time. "In cross-sectional studies, certain characteristics of students at different class levels are measured at the same time, and change (or stability) is inferred from comparisons" (4, p. 32). But this approach suffers from two very limiting faults (4). First, freshmen-senior differences might be attributable to differential characteristics of the students, rather than to any impact of college programs. Cross-sectional data obscures the input differences that might exist among the various classes.

The other potential fault of simple cross-sectional data has to do with the fact that, even if the current seniors were, as freshmen, very similar to the current freshmen, there may have been a selectivity factor at work within the senior class's four-year history of dropouts, such that the remaining seniors are a specific subset of their original freshman class and may very well have differed from current freshmen in some real sense. This implies that those who intend to use cross-sectional data must have a way of judging the similarities and differences among the various classes which are to be used in evaluating the programs.

The longitudinal strategy overcomes the first criticism of cross-sectional studies. "In this design, the same students, usually called a panel, are studied over time" (4, p. 52). Marcus, et al, (6) recognize a longitudinal strategy which studies different groups of people over time, calling this a trend study. This latter approach, however, still does not directly accommodate the fact that students who drop out of college may differ from those who do not; and the resulting data do not reflect this situation.

Feldman and Newcomb (4) suggest that the longitudinal strategy is preferable, in spite of its shortcomings. They also note that, even though cross-sectional studies suffer from certain methodological disadvantages with respect to longitudinal studies, the results of most such studies are often similar to those from longitudinal studies.

It is apparent that, whichever research strategy is adopted

by the decision maker, some analytical technique must be used to determine the existence of impact on the desired and/or expected student outcomes. Also determined must be the extent of that impact attributable to the designed programs, and the extent that it is likely due to the student inputs. This usually results in the analysis of change scores -- the difference between pre- and post-scores on a measure, with a treatment intervening chronologically between them. Since it is often impossible or undesirable for administrators to impact student outcomes through altering the characteristics of incoming students, the only way to affect outcomes is through program development and implementation. The treatment in this case is the program selected by the administrative decision makers to achieve some desired goals or objectives. According to Marcus, et al. (6) change scores suffer from serious methodological problems because they are often artificially dependent on initial scores. Therefore, in order to work with such data, these problems must be understood; and analytical techniques designed to overcome them must be implemented.

The most serious methodological problems associated with change scores have to do with the statistical phenomena of regression and ceiling and floor effects (4, 6). Regression refers to the tendency for initially extreme scores to regress toward the mean scores on subsequent measures regardless of the effects of independent variables. Ceiling and floor effects occur when an individual's initial response is at or near the extreme position of the scale. This results in a situation in which the respondent has little or no room to make even more extreme responses in the same direction in subsequent measures. As a

result, people who initially score in an extreme position have little opportunity to demonstrate anything more than little or no change on the item. These artifacts of change data cause less reliable results to occur when analyzing the impact of various programs.

A separate, but equally important, question to be considered by decision makers is that of determining the amount of variation that occurs in the outcome measures that is attributable to the specific program relative to the amount that is really dependent on the student inputs to the program. This question becomes one primarily of research methodology and statistical analysis techniques.

Both Feldman and Newcomb (4) and Marcus, et al. (6), acknowledge this point and present discussions centered around the concern of effect of initial position on student outcome data. This becomes a crucial question for the purposes of the administrative decision maker. If it is not possible to ascertain the separate contributions of student input and program effects to the impact on student outcomes, the evaluation efforts will provide them with little more than questions about whether observed effects were due to the developed program(s) or to the characteristics of students entering the programs.

Feldman (3) discusses several attempts by other researchers to account for initial student inputs. His analysis indicates that the most pervasive technique in the literature seems to be the input-output analysis, used extensively by Astin and his associates (2). It is a technique for statistically determining residual scores, and then attributing the variation in residual

scores to the environmental or program characteristics. Kerlinger (5) describes the satistical procedure as being one in which residual scores are "calculated by predicting the post-test scores from the pre-test scores on the basis of the correlation between pre-test and post-test scores, and then subtracting these predicted scores from the post-test scores to obtain the residual gain scores" (5, p. 337). Feldman and Newcomb (4, pp. 138-139) and Marcus, et al. (6. p. 117) both present similar descriptions of the technique. Typically, step-wise linear regression is the statistical technique employed in an input-output analysis (6).

However, Feldman and Newcomb (4) suggest that the input-output model is not without faults. First, logic dictates that the decision maker must consider all potentially relevant antecedent factors on which students differ. All these factors must then be worked into the regression model to derive an expected value to be used in computing the residual scores. This may not be a feasible requirement, thus resulting in an analysis that is, in principle, lacking a complete analysis of input variables.

A more troublesome and pervasive problem with residual scores lies in the lack of any way of demonstrating the existence of joint effects. Because relationships often exist between incoming students and environmental characteristics, (4, 6) an assumption of independence is dangerous. Therefore, the regressed effect of student input on student outcomes tends to incorporate the joint effect of student input and environment, and thus tends to overstate the impact of student inputs and understate the impact of the environment. This situation is acknowledged by Feldman and Newcomb, (4) Feldman, (3) and Marcus, et al (6). While

there is no real answer to this problem, there are analyses which can be used to shed some light on the issue of joint effects.

Feldman and Newcomb (4) discuss several of the techniques used to overcome this problem. The first is the use of a single regression equation including both input and environmental variables. The predicted variance of the outcome variable may then be partitioned into three components: 1) the variance due to inputs independent of environment; 2) the variance due to environment independent of inputs; and 3) the variance due jointly to input and environment.

Feldman and Newcomb (4) also report several of Astin's methods of overcoming this problem. One suggestion is that the investigator first conduct a standard residual analysis; and, for those environmental characteristics which appear to have significant results, an upper-bound estimate can be made by re-estimating the effects of those specific characteristics (by computing their relationship to the student outcomes without accounting for student input variables). Such an analysis results in two estimates, one from the analysis of the residual scores which under estimates the effect of environmental characteristics, and one from the straight analysis of the environmental characteristics which tends to overestimate their effects. From such dual sets of figures, the investigator can be reasonably sure that the true figure lies somewhere between the two estimates at hand.

Astin (1) is also cited as having confronted this problem by getting other estimates of "upper bounds."

> "He has done this by calculating the proportion of variance in achievement attributable to college environment alone as well as that attributable to college environment independent of student input; likewise, he determined the proportion of variance in achievement attributable to student input independent of college environment, in addition to the proportion attributable to student input alone" (4, p. 363).

With these cautions in mind, it seems that the use of the input-output design might provide a sophisticated analytical technique for the administrative decision maker.

However, the decision maker within a single institution will have to modify the inter-institutional methodology developed by Astin. For example, programs designed to effect the entire student body can be analyzed through the residuals of students categorized by class. Those students who were enrolled before the new program was implemented (most likely the upperclassmen) would be expected to be affected less than those who were exposed to the program from the time they first enrolled. Likewise, the impact of programs aimed at students majoring in one academic field could be compared to that of students not in that academic field; and the residuals of one group analyzed with respect to the other. Another example would be to compare the residuals of students experiencing one kind of environment (that is, those living in residence halls) with those of students not experiencing that kind of environment. Such analyses should lead to conclusions about the impact of implemented programs on desired student outcomes.

To the extent that decision makers can select certain groups of students for the programs which are being planned, the use of simple experimental and control group research designs, coupled

with the residual analysis of input-output methodology, is possible. Because of the unique characteristics of the educational process, it is often difficult or impossible to randomize subjects in the various experimental and control groups. To the extent that randomness can be achieved, then the simple, basic research designs can be employed; but, if randomness is not possible, it becomes important for the researcher to account for differential characteristics among experimental and control group members. The input-output analysis technique does so. This technique can then be used to analyze the effect of the intra-college programs on student development outcomes.

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